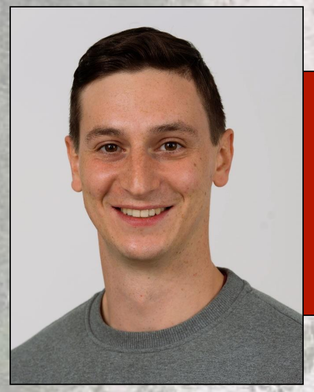
Improving Landslide Detection and Mapping on SAR data through Deep Learning



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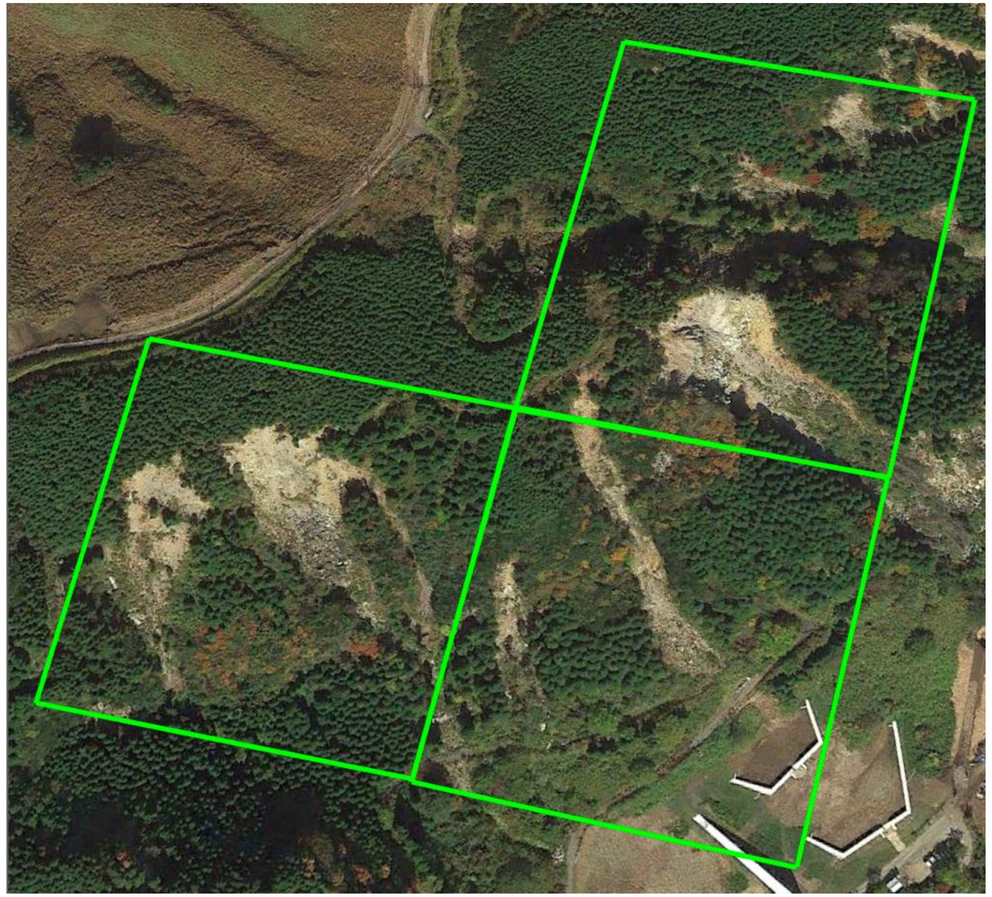
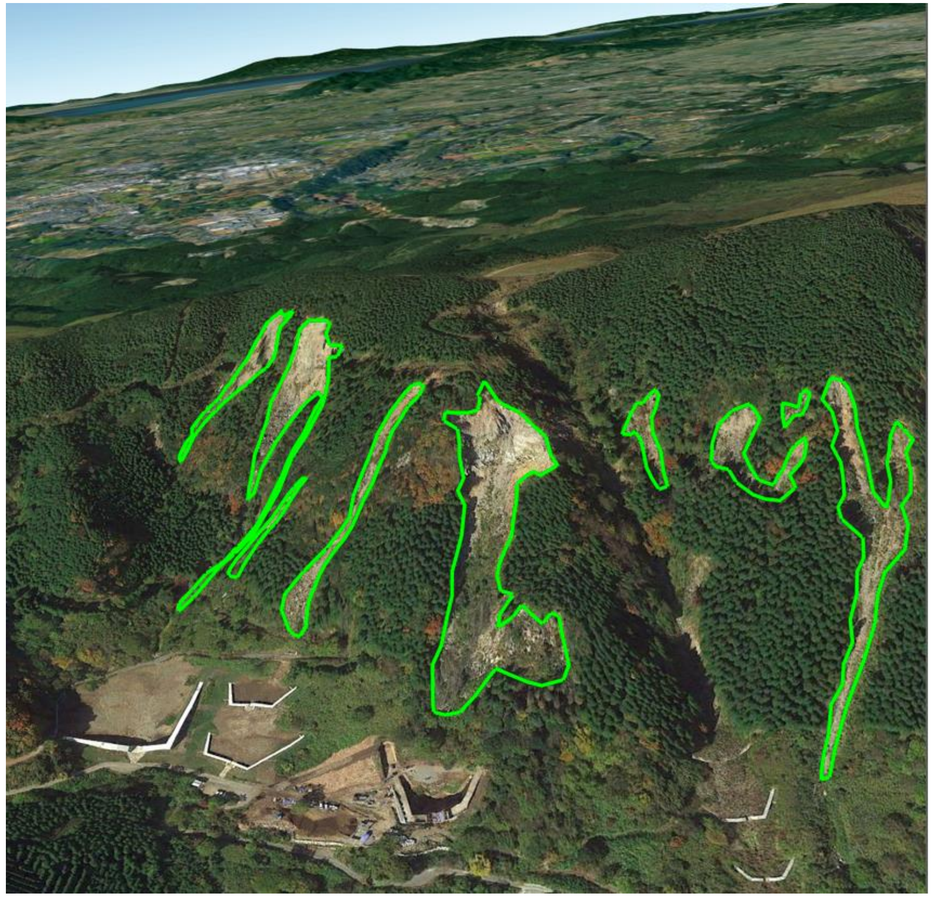
ITU Workshop in Artificial Intelligence for Natural Disaster Management

LANDSLIDE DETECTION



LANDSLIDE SEGMENTATION



WHY LANDSLIDES ?

- 2004 – 2016: around **56 thousand** deaths (Froude et al., 2018).

- US: **2-4 billion $** per year (USGS).

MULTIPLE LANDSLIDE EVENTS

- Earthquake and intense rainfall can trigger **multiple landslides events (MLE)**.

- MLE can damage **wide areas** in a **short time span**.

Source: https://blogs.agu.org/

MULTIPLE LANDSLIDE EVENTS

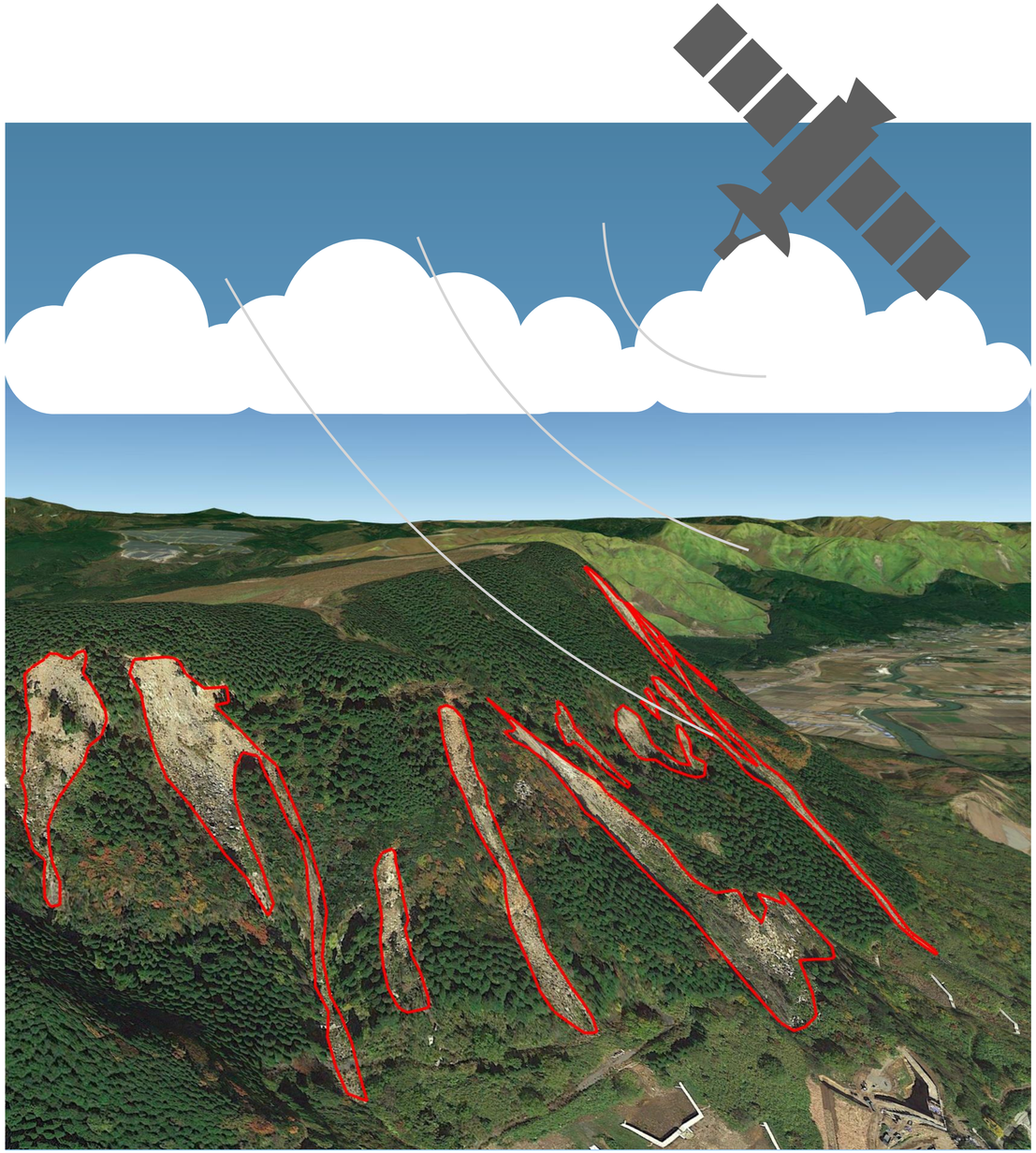
Location	Year	Trigger	Number of landslides
Wenchuan, China	2008	Earthquake	*100,000
Rio de Janeiro, Brazil	2011	Rainfall	3,622
Rasuwa, Nepal	2015	Earthquake	*21,000
New Zeland	2016	Earthquake	*10,000
Dominica	2017	Rainfall	9,960
Hokkaido, Japan	2018	Earthquake	*8,000
Palu	2018	Earthquake	7,063
Papua New Guinea	2018	Earthquake	*10,000
Kerala, India	2018	Rainfall	4,728
Kodagu, India	2018	Rainfall	343

* approximately

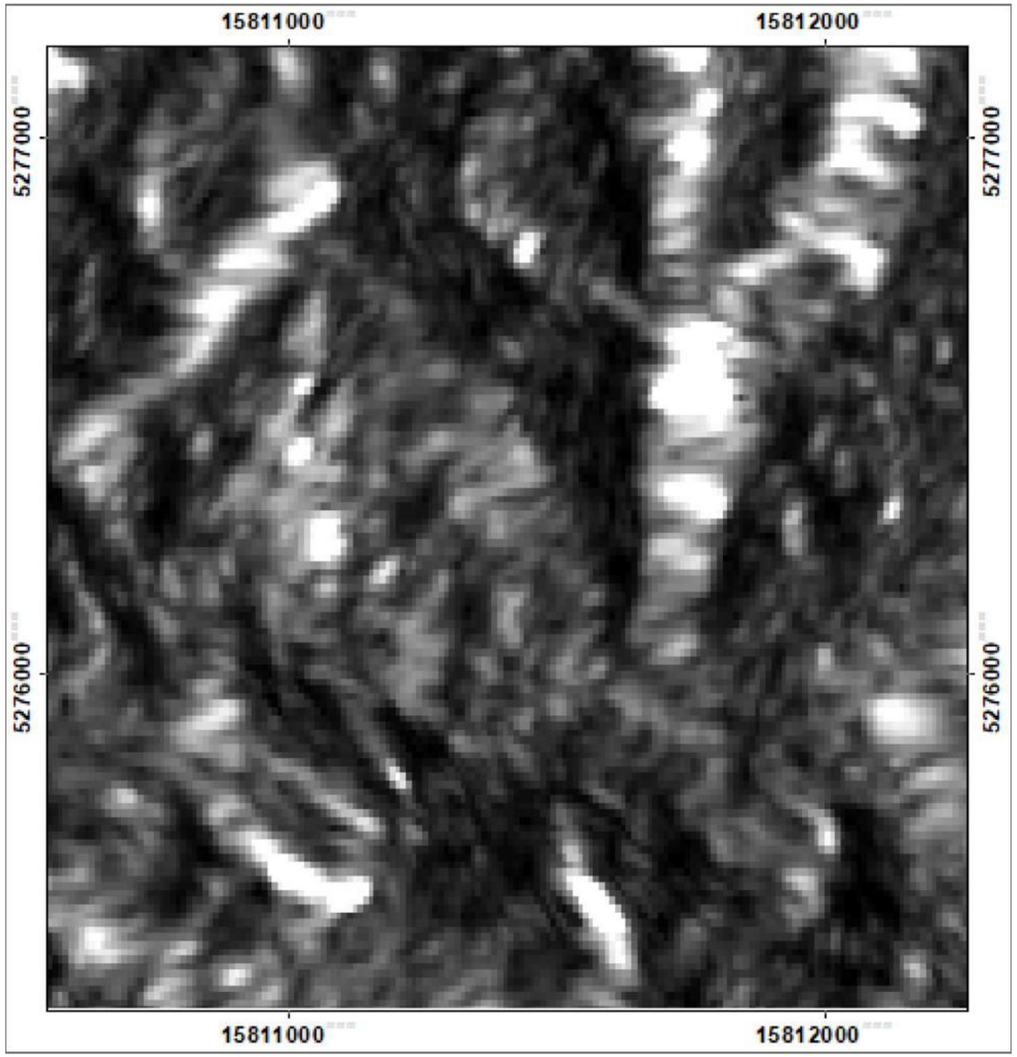
LIMITATION OF OPTICAL DATA

PURPOSE OF THE STUDIES

- Overcome **weather-related limitations** of optical data for rapid landslide detection and mapping.



SAR VV AMPLITUDE



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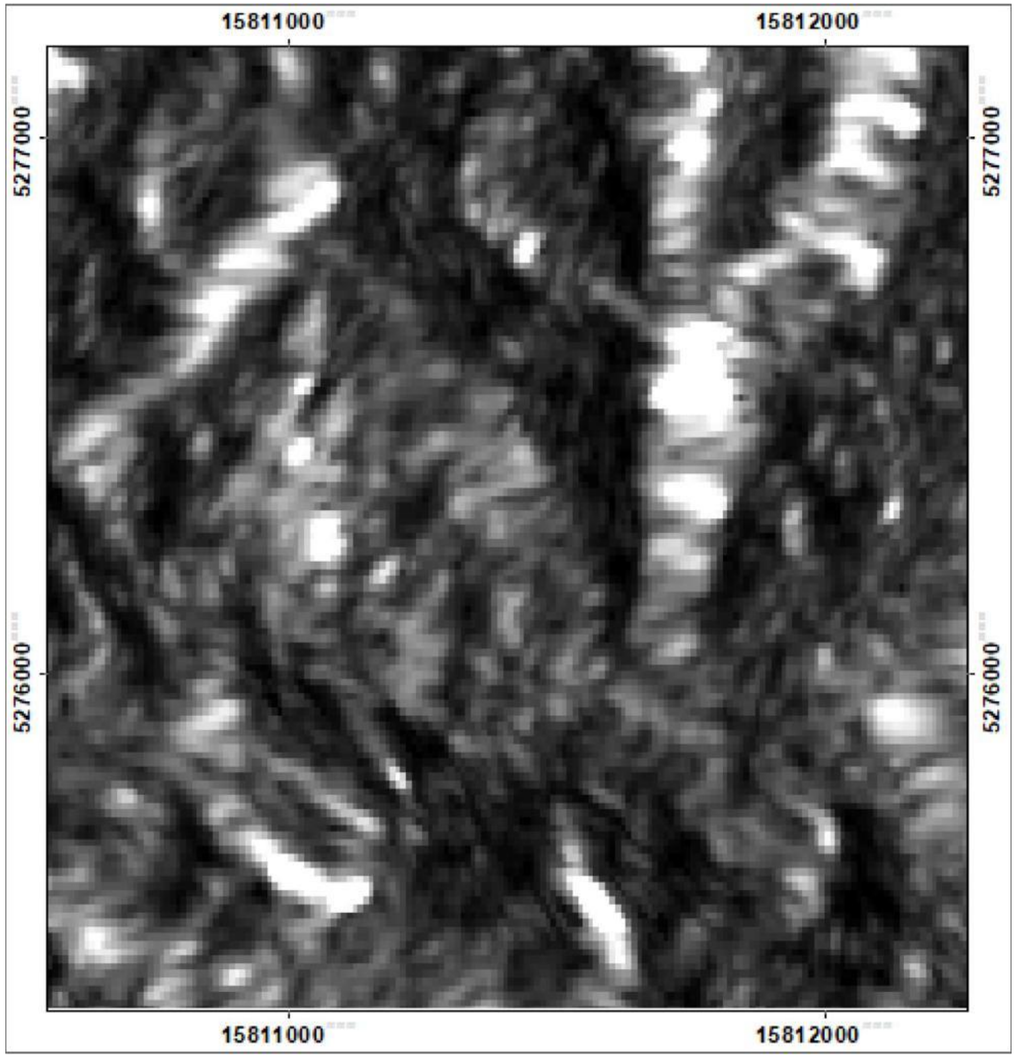
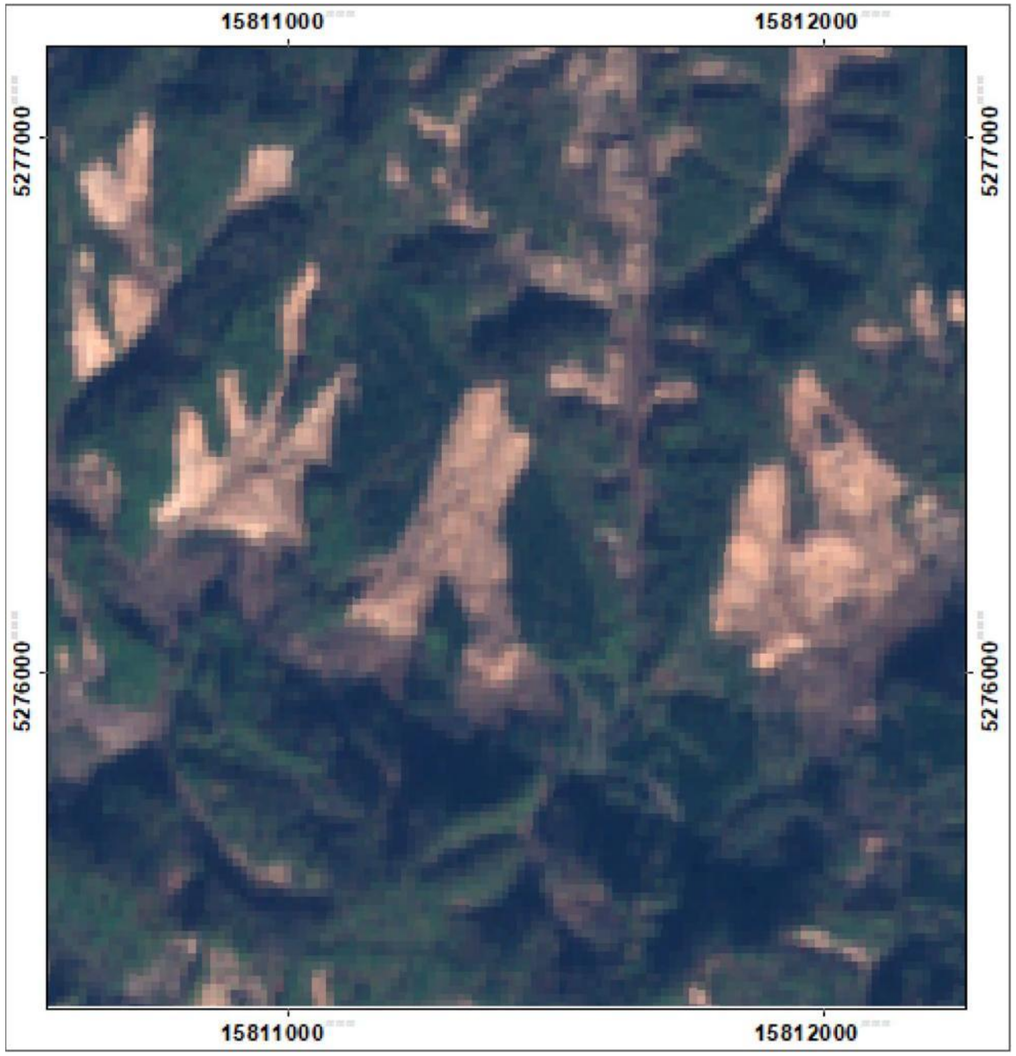
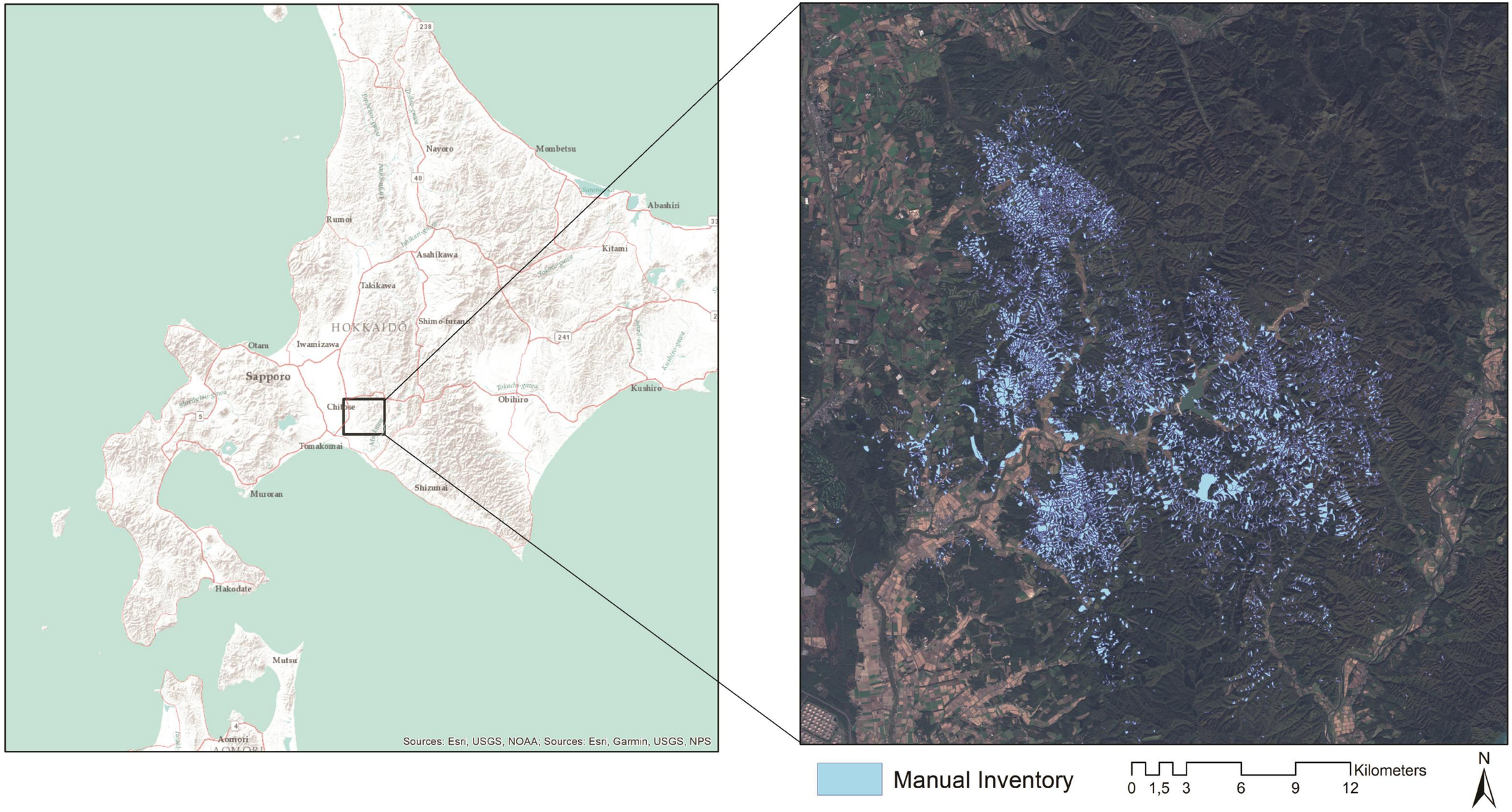


TRUE COLOR IMAGE



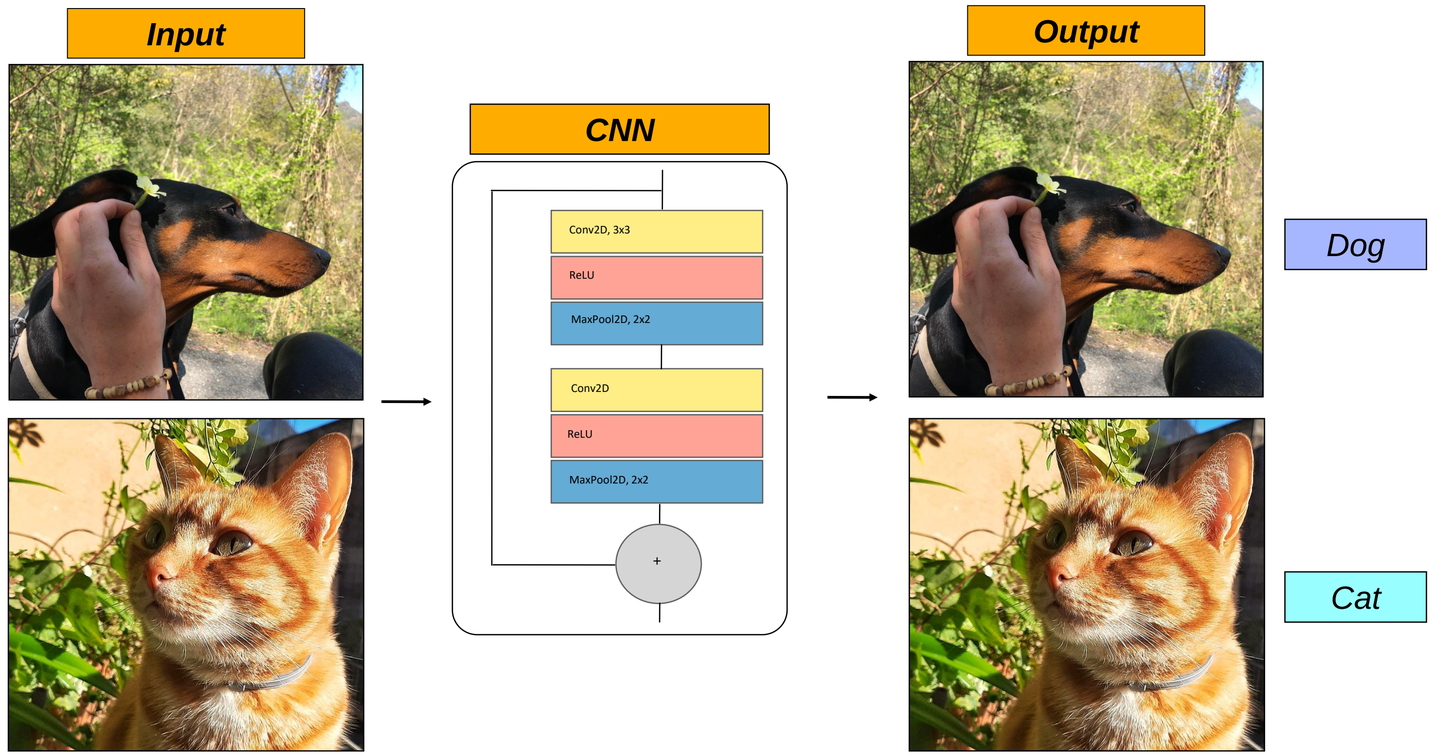
HOKKAIDO, JAPAN



CONVOLUTIONAL NEURAL NETWORKS (CNNs)

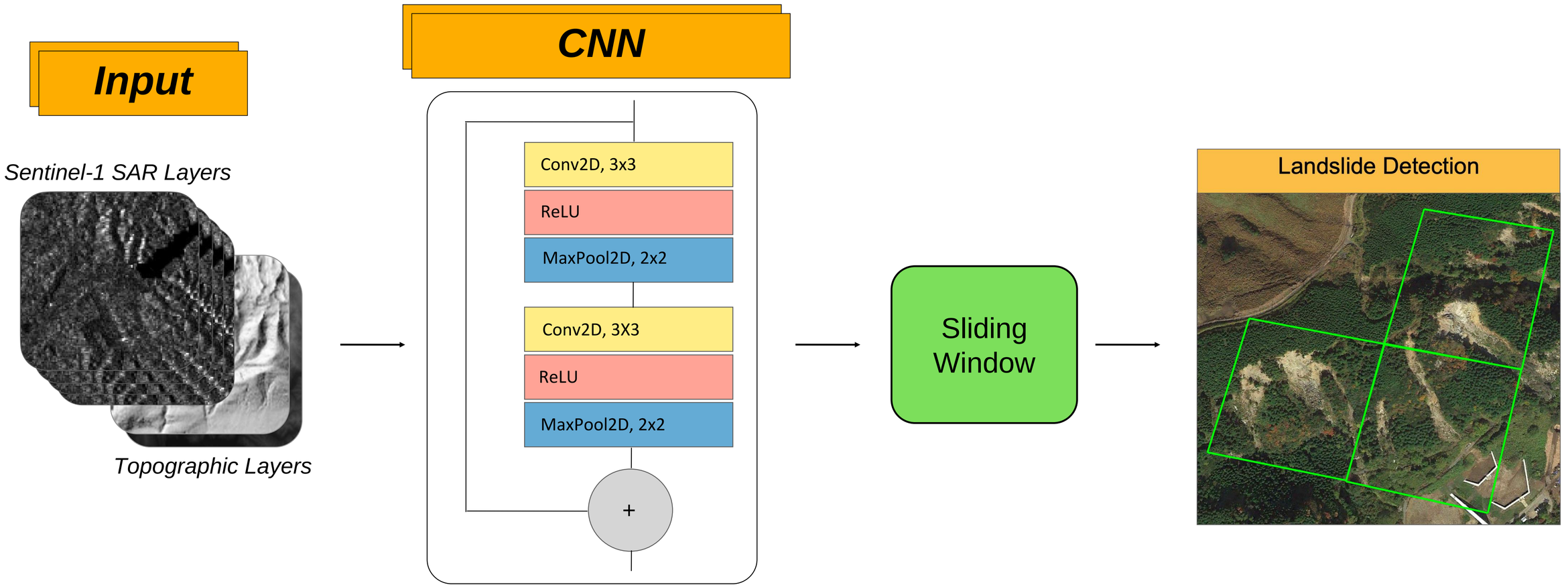
- **Applications:**
  - Face recognition on social media.
  - Object detection for self-driving cars.

- **Main requirement:**
  - Huge dataset of labeled images.



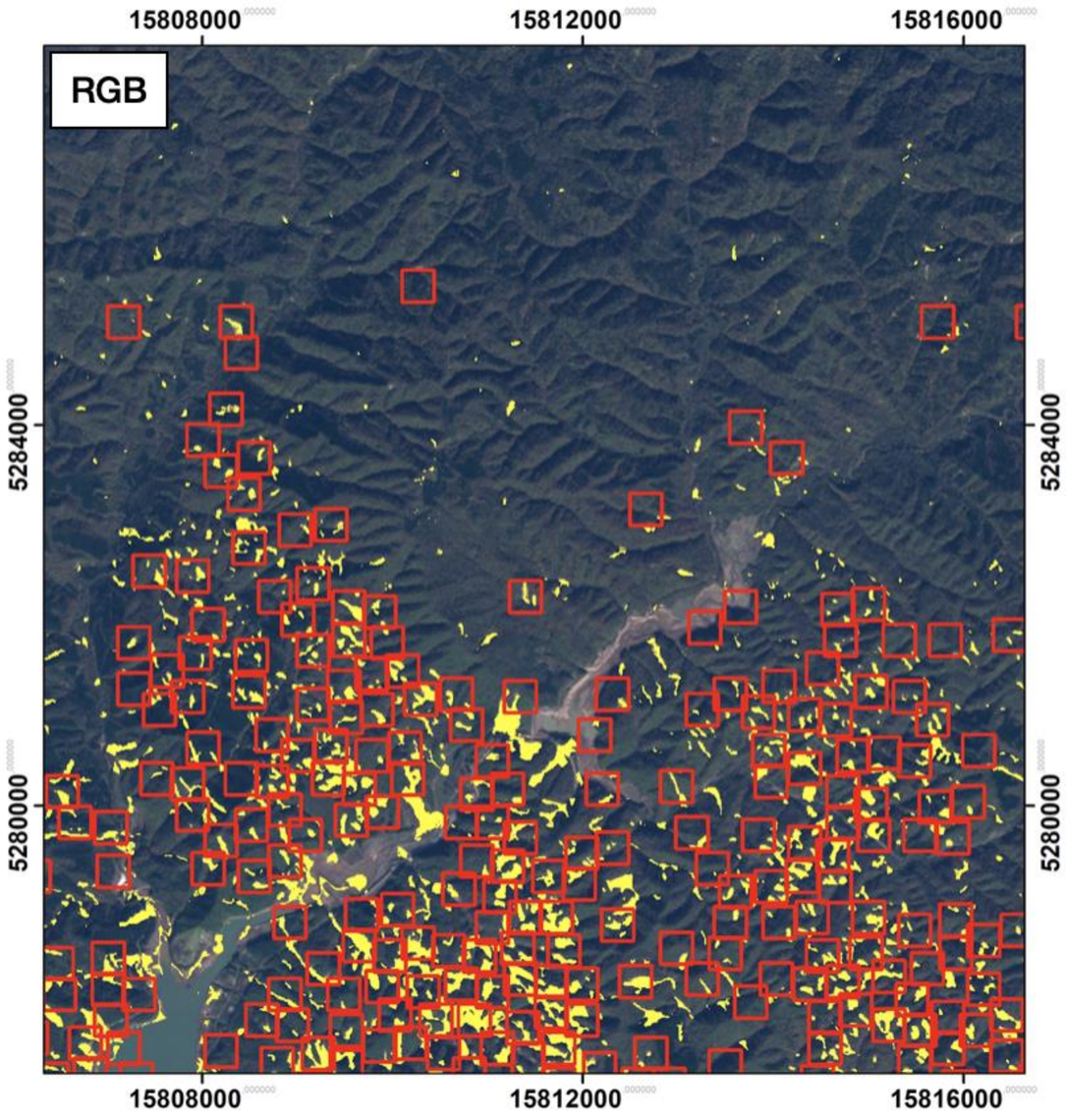
LANDSLIDE DETECTION

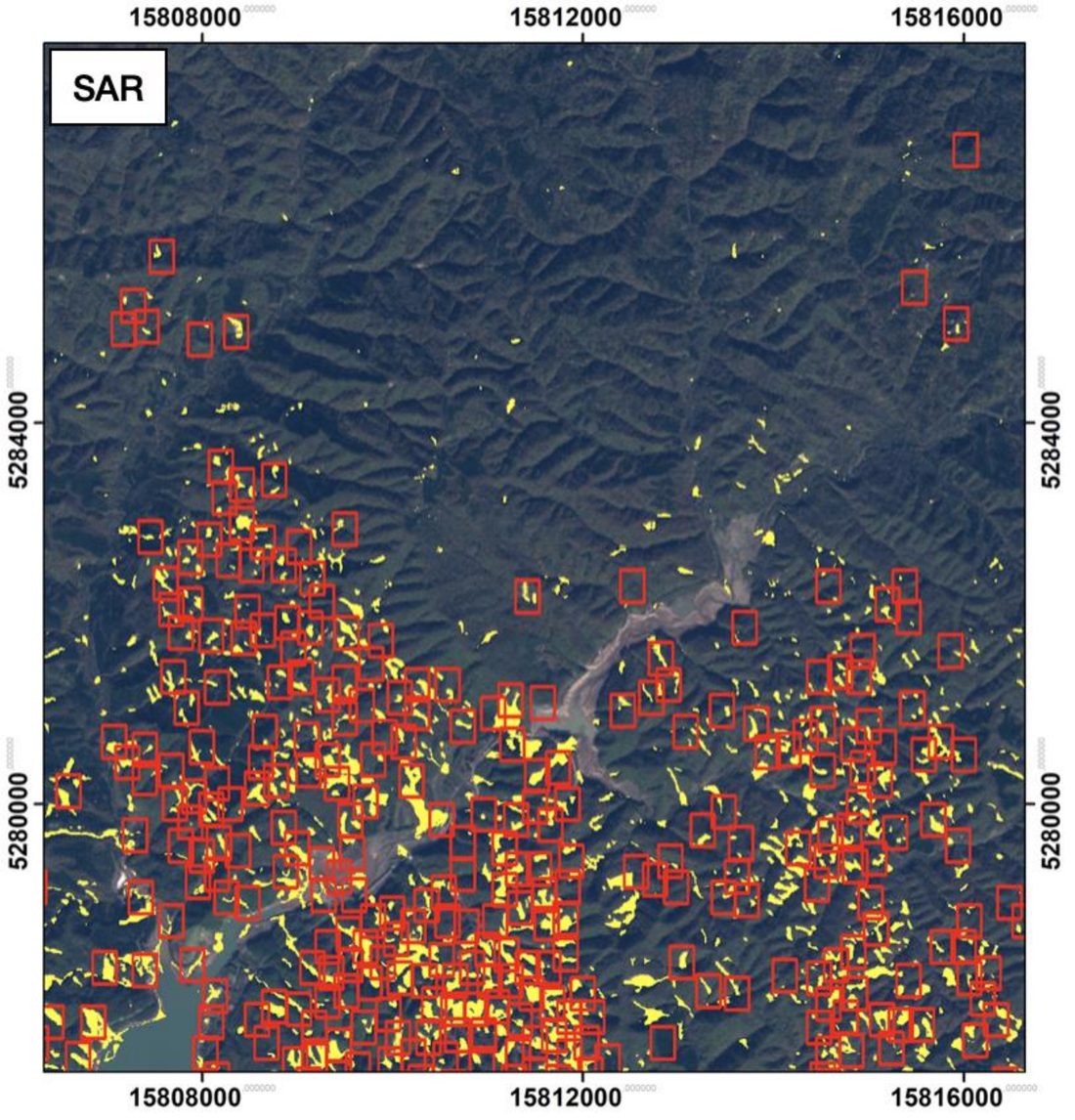
Nava et al., 2022a



LANDSLIDE DETECTION

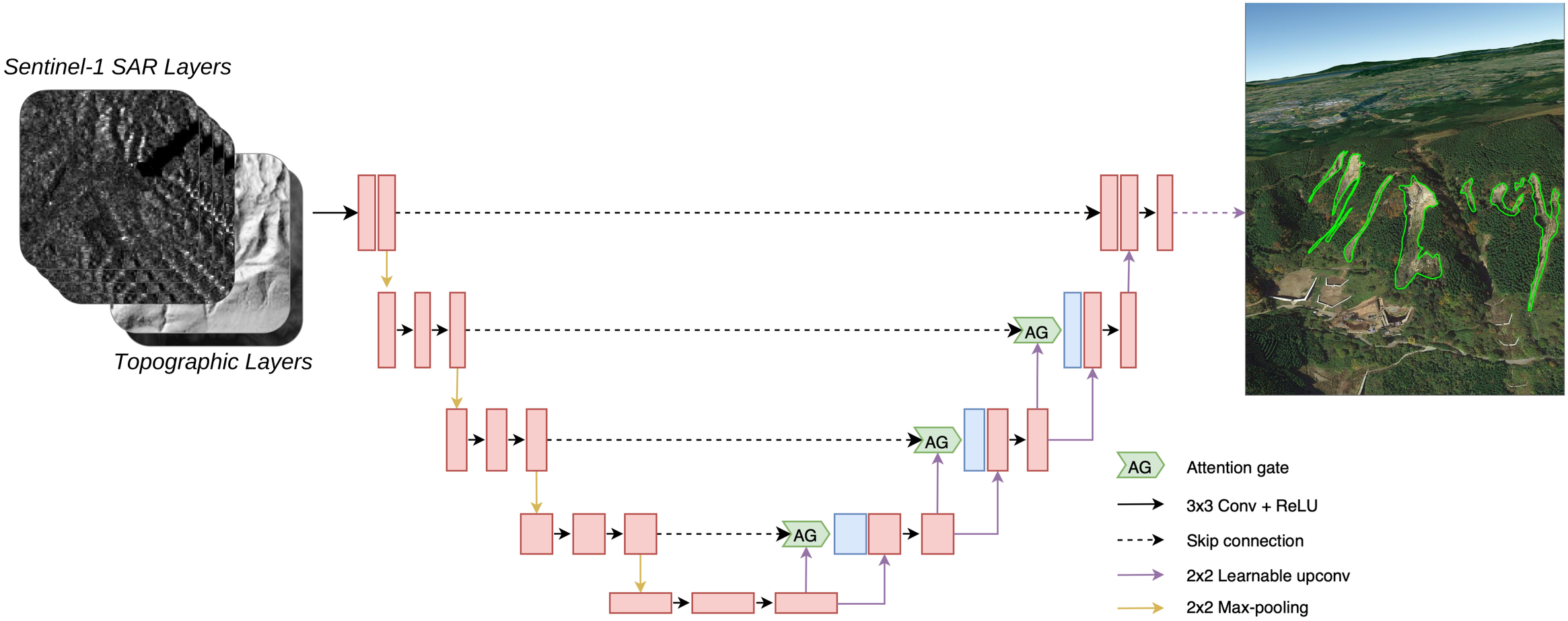
Nava et al., 2022a



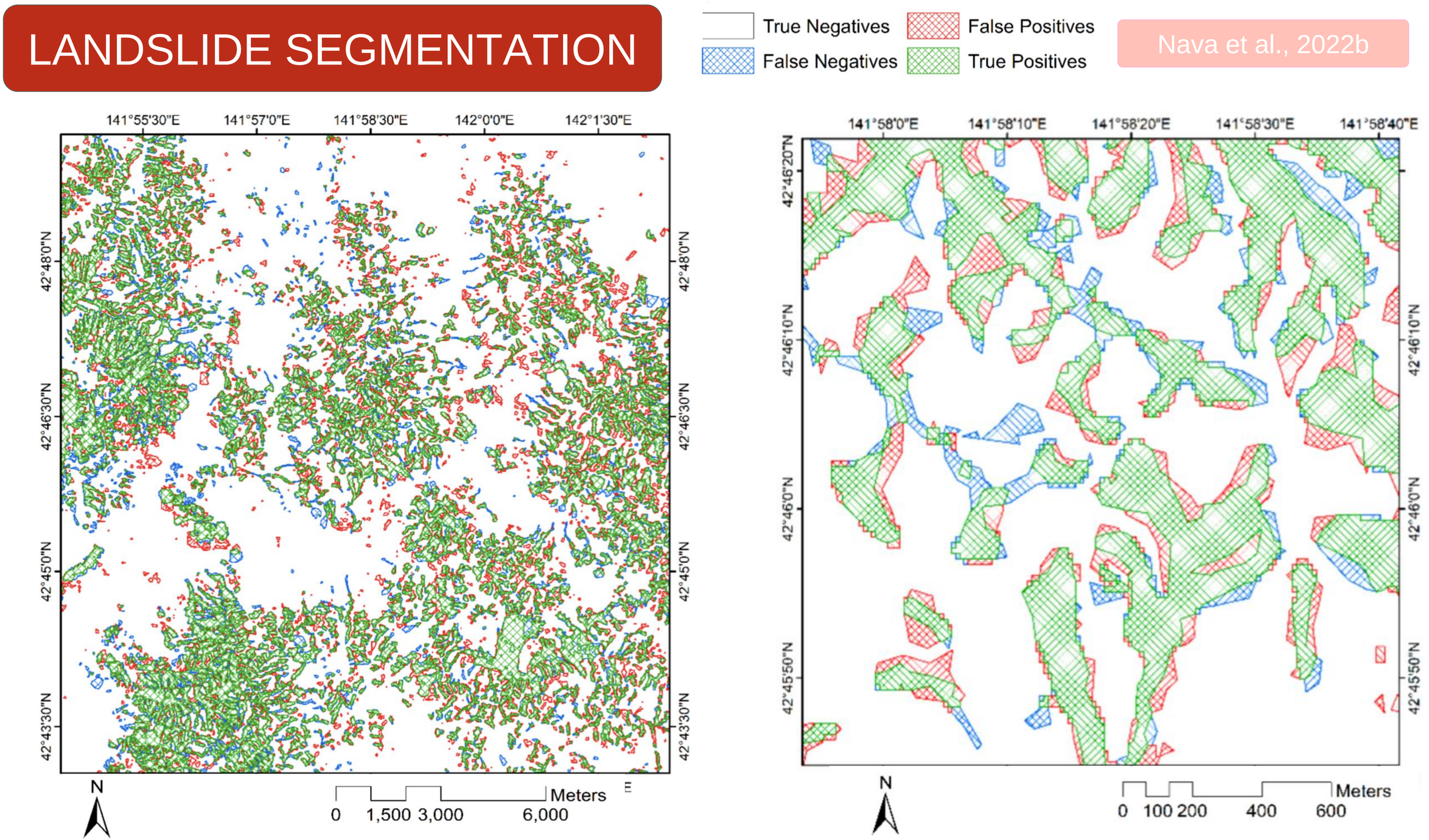


LANDSLIDE SEGMENTATION

Nava et al., 2022b



LANDSLIDE SEGMENTATION



Nava et al., 2022b

CONCLUSIONS

- DL and pre- / post- event amplitude SAR data (VV) allows to **automatically detect and map landslides** also in presence of **cloud cover.**

- Limitations due to **geometric distortions**.

- **Relevant benefits:**
  - Greatly reduces response time of emergency operators.
  - Potentially allow to create historical records with location and timing of landslide occurrences.

Nava, L., Monserrat, O., & Catani, F. (2021). Improving landslide detection on SAR data through deep learning. *IEEE Geoscience and Remote Sensing Letters*, *19*, 1-5.

Nava, L., Bhuyan, K., Meena, S. R., Monserrat, O., & Catani, F. (2022). Rapid Mapping of Landslides on SAR Data by Attention U-Net. *Remote Sensing*, *14*(6), 1449.

THANK YOU

FOR

YOUR

ATTENTION

REFERENCES

- Wang, F., Fan, X., Yunus, A. P., Siva Subramanian, S., Alonso-Rodriguez, A., Dai, L., ... & Huang, R. (2019). Coseismic landslides triggered by the 2018 Hokkaido, Japan (Mw 6.6), earthquake: spatial distribution, controlling factors, and possible failure mechanism. Landslides, 16(8), 1551-1566.
- Froude, M. J., & Petley, D. N. (2018). Global fatal landslide occurrence from 2004 to 2016. Natural Hazards and Earth System Sciences, 18(8), 2161-2181.